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FAIR RATES AND RATES OF RETURN IN A DEREGULATED RAIL INDUSTRY

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ABSTRACT

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This paper addresses the question of whether "fair" rates to captive shippers are compatible with "fair" rates of return for the railroads in the period of quasi deregulation since the passage of the Staggers Act in 1980. This question is analyzed by developing a simple model of "polar" Ramsey pricing in which a public utility faces a break-even constraint while selling in two sectors: a competitive one in which price equals marginal cost; and a captive one, which has to bear the entire revenue burden. Under these circumstances, the markup in the captive sector can be shown to depend on the degree of economies of scale and the marginal-cost revenue shares in the captive and competitive sectors. Using the results of a translog cost function based on panel data of Class I railroads through 1974 - 1986, the paper shows that returns to scale are sufficiently large to cause coal rates to rise to socially unacceptable levels if captive coal shippers have to bear the entire revenue burden. Since, however, railroads currently earn a substantial markup over marginal costs on manufactured goods, the two goals should be compatible for most railroads under prevailing competitive relationships between the rail and the trucking industry.

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1. Introduction and Overview

Ever since the passage of the Staggers Act of 1980, there has been substantial controversy over the extent and nature of the regulation of rates on coal and other captive traffic that do not have ready access to other modes of transport or other sources of supply. The basis of this controversy lies primarily in the contradictory provisions of the Staggers Act of 1980, which on the one hand call for "revenue adequacy" to permit the railroads to earn a fair rate of return on their capital, while on the other hand require that shippers receive protection in markets in which railroads exhibit market dominance.[1]

Under current practices followed by the Interstate Commerce Commission (ICC), this protection is rather minimal and is effectively limited to a rate ceiling based on the stand-alone costs of the rail service provided to the captive shipper.[2] In response to this stance of the ICC, a vigorous consumer group has developed in recent years, lobbying strongly to reintroduce regulation and to set an effective rate ceiling on shipments to captive shippers.[3]

In assessing the correct policy to follow with respect to the establishment of rate ceilings on any rail shipments, there are four major issues to assess: first, the degree of scale economies that the railroads experience; second, the degree to which the railroads are subject to strong competitive pressures; three, the nature of scale economies and competitive pressures in the short-run and in the long-run; and four, the ease with which the transition from a short-run to a long-run equilibrium can occur.

To assess the significance of these issues, it is useful to consider two

alternative scenarios - one pessimistic and the other optimistic. Under the pessimistic scenario, the railroads are not only characterized by significant returns to scale in the short-run, but also in the long-run when they have made optimal adjustments in their capital stock. In addition, much of their traffic is subject to strong competitive pressures, which grow over time as truck competition becomes stronger (e.g. double bottoms are permitted over the interstate highway system) and "captive" utilities develop alternative sources of supply.

In this case, the contradiction between revenue adequacy and equitable rates on the remaining captive shippers is apparent. With marked economies of scale, marginal cost pricing yields a large revenue short-fall and the "captive" base may be too small to provide sufficient revenues to permit the railroads to earn a fair rate of return at markups that are considered equitable.[4]

Under the optimistic scenario, any existing marked economies of scale are essentially viewed as a short-run phenomenon arising from the inefficient capital stock imposed upon the railroads by regulation. When the railroads have a chance to adjust their capital stock and their networks to optimal levels, economies of scale become much more muted, if not actually disappear. Moreover, through the economies obtained by achieving efficient utilization of capital, labor, and the network, rail costs are lower than truck costs for a wide range of truck-competitive traffic (e.g. finished autos and auto parts, steel and metal products, etc.) so that railroads can earn some markup on much of their competitive traffic. Thus even though the share of captive traffic may be quite small, the revenue burden placed upon it should also be relatively small. Consequently under this scenario, workable competition should be possible, and the basic policy problem is a transitional one of moving from a short-run quasi-regulated equilibrium characterized by a high degree of economies of scale to a long-run equilibrium

characterized by modest scale economies and workable competition.[5]

To analyze these questions, in Section 2 this paper develops a simple model to show the relationship between the degree of economies of scale, the share of competitive traffic, and the revenue burden that must be borne by the captive sector to ensure revenue adequacy. In Section 3 it then assesses the nature of returns to scale in the rail industry in the previously regulated and the current quasi regulated environment. Section 4 considers the actual behavior of rates during the sample period and addresses the question of whether it is possible for the railroad to have a rate structure that would be viewed as "equitable" while ensuring revenue adequacy. Section 5 presents a brief summary and discusses the policy implications of the findings.

2. Revenue Burdens in a Stylized Two-Sector Public Utility

To analyze the revenue burden that could accrue to captive coal shippers, it is useful to consider a stylized public utility operating under a break-even constraint and consisting of a "competitive" and a "captive" sector.[6]

In the first sector, competitive forces keep prices close to or equal to marginal cost, implying that the revenue requirements needed to meet the break-even constraint must be predominantly generated by the captive sector. The problem at hand is to see under what conditions a Ramsey rate structure will generate prices that are consistent with general notions of equity. Consider a firm with economies of scale equal to r defined as:[7]

$$r = \frac{C(x_1, x_2)}{x_1 \partial C/\partial x_1 + x_2 \partial C/\partial x_2} = \frac{C(x_1,\ x_2)}{\sum_i \mu_i x_i} \qquad (1)$$

where $\mu_i = \partial C/\partial x_i$. Define R as the revenue that would accrue to the firm if it

followed marginal cost pricing so that $R = \Sigma\, \mu_i x_i$. Thus

$$rR(x_1,\ x_2) = C(x_1,\ x_2).$$

Suppose the firm operates under a break-even constraint so that instead of charging μ_i, it charges p_i for each output, where $p_i = \lambda_i \mu_i$ and satisfies the following:

$$\sum p_i x_i = C(x_1,\ x_2). \tag{2}$$

This implies, however, that

$$rR = \sum p_i x_i. \tag{3}$$

Solving for r yields the following expression:

$$r = \sum_i \lambda_i \gamma_i \tag{4}$$

where $\lambda_i = p_i/\mu_i$, the price-marginal revenue cost markup that satisfies the break-even constraint in sector i; and $\gamma_i = \mu_i x_i/R$, the marginal cost revenue share in sector i. From this it is straightforword to obtain the following expression for the markup in the captive sector that is needed to satisfy the break-even constraint:

$$\lambda_2 = \frac{r-\lambda_1\gamma}{1-\gamma} \tag{5}$$

where γ and $(1-\gamma)$ respectively represent the marginal-cost revenue share in the competitive and captive sectors.

If the regulators maximized welfare subject to a break-even constraint, the following Ramsey markups would obtain:

$$\lambda_i = 1/(1 + \theta/\epsilon_i) \qquad (6)$$

where ϵ_i represents the elasticity of demand in the ith sector and θ represents a constant reflecting the severity of the break-even constraint. Instead of solving explicitly for the Ramsey markups,[8] let us assume that the captive sector must bear the full burden of the break-even constraint and consider the polar case in which the "competitive" sector is characterized by perfect competition so that $\epsilon_1 = -\infty$ and $\lambda_1 = 1$. In this case eq (5) indicates that the markup in the captive sector required to satisfy the break-even constraint is independent of the elasticity of demand in that sector. Thus in this polar case, the Ramsey rate structure can also be expressed in terms of a cost-based rate structure unrelated to the elasticity of demand.

This polar Ramsey markup is positively related to the measured returns to scale and the share of competitive traffic. This makes intuitive sense, since the larger the returns to scale, the greater the revenue deficit caused by marginal cost pricing; and the larger the competitive sector, the greater the burden that must be placed on the captive sector to recoup the revenue deficit. This can be seen in Table 1, which shows the value of λ_2 for different values of r and γ.

When the returns to scale are quite low (e.g., $r \leq 1.2$) and when the share of captive traffic is relatively large (e.g., $1-\gamma \geq 25\%$), the revenue burden on the captive sector is relatively low and consistent with generally held views of equity. If, however, returns to scale are relatively high (e.g., $r \geq 1.5$) or the share of captive traffic is relatively small (e.g., $1-\gamma \leq 25\%$) the revenue burden

Table 1

Required markups over
marginal cost in captive sector,
by measured returns to scale
and traffic share in competitive sector.

	r = 1.05			r = 1.1			r = 1.2		
Required Markup in Captive Sector	γ			γ			γ		
	.5	.75	.9	.5	.75	.9	.5	.75	.9
λ_2	1.1	1.2	1.5	1.2	1.4	2.0	1.4	1.8	3.0
	r = 1.5			r = 1.8			r = 2.0		
Required Markup in Captive Sector	γ			γ			γ		
	.5	.75	.9	.5	.75	.9	.5	.75	.9
λ_2	2.0	3.0	4.0	2.6	4.04	9.0	3.0	5.0	11.0

placed on the captive shippers could reach levels that would not necessarily be thought of as distributionally acceptable. Thus in the presence of marked economies of scale and a small captive sector, it may not be possible to obtain both revenue adequacy and an equitable revenue burden for captive shippers.

More generally, of course, the relationship between economies of scale, the share of the competitive sector, and the Ramsey markups is given by equation (5). Since $\lambda_1 = 1$ in the presence of perfect competition, this indicates that the maximum Ramsey markup in the captive sector should be set by the polar case. Thus if in the polar case of perfect competition in the competitive sector, the

values of r and λ_2 are such that the Ramsey markup will be socially acceptable, they should be also socially acceptable in the presence of finite elasticities in the competitive sector. Consequently, for policy purposes, it is useful to analyze the polar case first to see if the polar Ramsey markups will violate normally held views of equity. Nevertheless, it is important to note that equation (5) provides a general expression for the markups in the two sectors that would ensure revenue adequacy.

3. Returns to Scale and Capital Adjustments

In assessing the quasi-regulated rate structure that currently exists and its potential fully deregulated counterpart, it is important to note that distributional considerations have not only traditionally played a major role in regulatory policy, but will also continue to be relevant. Existing shippers, who made decisions concerning plant locations on the basis of a set of regulatory rules and a given railroad equilibrium, certainly have some justification in arguing that they should not have to bear the full burden of moving to another equilibrium based on a different set of regulatory rules. Moreover, if there are substantial efficiency costs associated with the maintenance of the status quo, efforts should also be made to encourage the railroads to reach a new efficient equilibrium as speedily as possible and to find appropriate ways to compensate the adversely affected shippers. Thus in addition to the generally accepted notions of static second-best efficiency, we must also consider issues related to dynamic efficiency or how the transition can best be made from one equilibrium to another.[9]

Let us therefore begin by assessing the available evidence concerning the

regulated and the quasi-regulated structure of rail technology and the transitional path from a regulated equilibrium to the quasi-regulated equilibrium. We will then consider alternative pricing policies in the light of this evidence.

3.1 The Analysis of Costs and Technology

The estimated returns to scale used in this paper are based on Berndt et al. (1990), which estimates a cost function using a time-series, cross section of the major class I railroads for the period 1974-1986.[10] Thus this data set provides a picture of the technological structure of the railroads during the recent period when regulation existed and when it has been substantially reduced. Consequently by estimating the returns to scale over the sample period for representative railroads, it should not only be possible to analyze the appropriate rate structure to adopt during the period immediately following deregulation, but also the rate structure that would be appropriate in a long-run equilibrium when the railroads are able to adjust their capital stock in an optimal fashion.[11]

Because of our interest in coal rates, we will analyze the behavior of the five railroads that are heavy coal carriers (Burlington Northern, Conrail, CSX System, Norfolk Southern System, and the Denver Rio Grande). In addition, because of the number of significant mergers that have taken place during the past decade, it is also useful to focus on the merged rail systems (the four large coal systems, plus the Union Pacific System) to see if they have behaved differently from the other railroads.[12] Finally, for purpose of comparison, we will consider the behavior of a number of representative non-coal, non-merged systems: the Atchison, Topeka and the Santa Fe (a large Western road); the Illinois, Central Gulf (a large Southern road); the Grand Trunk Western (a small Eastern road); the Missouri Kansas Texas (a small Western road); and the Soo (a

small Western road)[13]

Berndt <u>et al.</u> (1990) estimate a translog approximation of a short-run variable cost function of the following general form:

$$C^S = C^s(y, w, x_F, t) \tag{7}$$

where C^s represents variable costs,[14] y represents total ton-miles, w represents a vector of prices for variable inputs (labor, equipment, fuel, and "other"), x_F represents way and structures (ws) capital, and t represents a vector of technological variables (miles of track, average length of haul, agricultural tonnage as a proportion of total tonnage, coal tonnage as a proportion of total tonnage, a time trend, and dummy variables to represent time since merger and time since deregulation). Although this specification uses an aggregate output variable of ton-miles, costs are permitted to vary with the composition of tonnage carried among agricultural goods, coal, and "other" commodities--primarily manufactured goods.

Because of the likelihood that there are firm-specific effects that are not fully captured in the available data (e.g. the rail network), it is useful to introduce dummy variables to reflect these firm-specific characteristics. Consequently, in estimating equation (7), firm-specific dummy variables were added to the intercept of the cost function and the linear terms of the input price variables. This procedure assumes, in effect, that firm-specific differences in technology consist of a "neutral" component and an input-specific component, but are independent of the firms' output, ws capital, and technological characteristics.[15]

Since the sample period included a substantial number of years in which rate

regulation was significantly reduced, it is likely that output and its related technological variables (ALH, % coal, % agriculture) are endogenous to the firm, rather than exogenous. Consequently, the cost function and its associated input share equations were estimated by a 3SLS procedure that assumed that the following variables and their transformations were endogenous: output, average length of haul, the proportion of coal traffic, and the proportion of agricultural traffic.[16]

Because of the importance of determining revenue adequacy for the railroads, it is important to evaluate different measures of returns to scale and to consider explicitly how measures of scale economies are related to the way in which output can change. In this paper, we follow most analyses of transport cost functions, and define output as ton-miles so that $y = T \cdot H$, where y = ton-miles; T = tons shipped; and H = average length of haul. Although a given percentage increase in tons or average length of haul will have an identical impact on ton-miles, in this specification it will not have the same impact upon costs, since average length of haul and the composition of output also enter as technological characteristics in the cost function.

The importance of this can be seen by considering the specified cost function, $C = C(y(H,T), H, t_c, t_a)$, where t_c and t_a respectively represent the share of total tonnage accounted for by coal and agriculture (i.e., $t_c = T_c /T$ and $t_a = T_a/T$) and the other arguments are supressed for convenience.

Taking the total differential of costs yields the following expression where e_{cy}, e_{cpc}, e_{cH} and e_{cpa} represent the partial elasticity of cost with respect to the relevant argument (e.g., $e_{cy} = \partial \ln C/\partial \ln y$).

$$\frac{dC}{C} = (e_{cy} - e_{cpc} - e_{cpa})\frac{dT}{T} + (e_{cy} + e_{cH})\frac{dH}{H} + e_{cpc}\frac{dT_c}{T_c} + e_{cpa}\frac{dT_a}{T_a} \tag{8}$$

If all tonnage changes proportionately, (i.e. $dT/T = dT_c/T_c = dT_a/T_a$), the elasticity of costs with respect to tons is simply given by the partial elasticity of cost with respect to output, i.e.,

$$\frac{dC}{dT}\cdot\frac{T}{C} \equiv E_{CT} = e_{cy} \equiv \frac{\partial \ln C}{\partial \ln y} \tag{9}$$

Similarly, if total tonnage and its components remain constant and average length of haul changes, the relevant elasticity of cost is given by

$$\frac{dC}{dH}\cdot\frac{H}{C} \equiv E_{cH} = (e_{cy} + e_{cH}) \equiv \frac{\partial \ln C}{\partial \ln y} + \frac{\partial \ln C}{\partial \ln H} \tag{10}$$

More generally, by dividing the expression given in eq (8) by the percentage change in ton-miles, we can obtain the following expression for the total elasticity of costs with respect to output:

$$\frac{dC}{dy}\cdot\frac{y}{C} = \alpha_T \tilde{E}_{CT} + \alpha_H E_{CH} + \alpha_C e_{cpc} + \alpha_A\, e_{cpa} \tag{11}$$

where e_{cpa} and e_{cpc} respectively represent the partial elasticity of cost with respect to the percentage of agriculture and coal traffic and α_T, α_H, α_C and α_A respectively represent the percentage change of the output component relative to the percentage change in total ton-miles (e.g., $\alpha_T = (dT/T)/(dY/Y)$). In addition, E_{CH} is defined as above (eq (10)) and $\tilde{E}_{CT} = E_{Cy} - e_{cpc} - e_{cpa}$. Finally, if all components of output change proportionately, this simplifies to the following expression:[17]

$$\frac{dC}{dy} \cdot \frac{y}{C}\Big|_{prp} \equiv E_{CP} = e_{Cy} + .5e_{CH} \tag{12}$$

Returns to scale are simply given by the reciprocal of the elasticity of cost. We thus define the following measures of returns to scale:

Tons: $S_{yT} = E_{CT}^{-1}$ (13a)

ALH: $S_{yH} = E_{CH}^{-1}$ (13b)

Weighted: $S_{yW} = E_{CW}^{-1}$ (13c)

Proportional: $S_{yP} = E_{CP}^{-1}$ (13d)

A priori, it is not obvious which of these measures is the most relevant. The returns to scale with respect to tons reflects the conventional measure of scale economies when ton-miles is the output measure and also reflects the usual measure of economies of density.[18] Moreover, since the composition of output is assumed to remain constant, this is analogous the the familiar measure of ray economies of scale. Since, however, tonnage increases proportionately, while average length of haul remains constant, this measure does not reflect a full proportionate increase in all of the components of output. This is given by the measure of proportionate returns to scale. Although this measure has a certain logic, it is important to note that it will magnify the measured economies of density, since a proportionate increase in tonnage and average length of haul will lead to a two-fold increase in the output measure, ton-miles.

This suggests that the most useful measure of returns to scale may be given by the measure of weighted returns to scale, which reflects the actual changes in the various components of output that have occurred over the sample period. Nevertheless, it is important to note that this measure may be highly volatile, since it is heavily dependent on the changes in each component of out-

put relative to the change in ton-miles. On balance, this indicates that the preferable measure of returns to scale is the one that is conventionally used, i.e., returns to scale with respect to tons or ton-miles. Since this assumes that the composition of traffic remains constant, it can also be thought of as a measure of ray economies of scale with respect to tons.

To date, we have not differentiated between short-run and long-run economies of scale. Because of the large amounts of fixed capital embodied in the railroads' way and structure, it is important to consider the relationship between short-run and long-run returns to scale and the relationship between the opportunity cost of capital and the firm's shadow value of capital. The formal relationships between short-run scale economies, the shadow value of capital, and long-run returns to scale can be seen by considering the following total cost function:

$$C^T = C^s(y, w, t, x_F) + \rho * x_F \tag{14}$$

where C^T represents total costs, ρ^* represents the opportunity cost of capital,[19] and the other variables have their previous meaning.

By differentiating equation (14) with respect to ws capital (x_F), it is straightforward to show that the equilibrium capital stock is obtained when the opportunity cost of capital equals the firm's shadow value of capital, which is defined as the savings that would accrue to variable costs if the stock of ws capital were raised incrementally. Thus:

$$\frac{\partial C^S(y,w,t,x_F*)}{\partial x_F*} = -\rho* \tag{15}$$

To obtain the optimal stock of capital we solve eq (15) for x_F*. Long run costs are obtained by substituting x_F* into the cost function given in eq (14). Long run returns to scale are then given by the reciprocal of the relevant long-run elasticity of cost with respect to output. Thus the long-run returns to scale are defined in the same way as the short-run returns to scale, with the optimal capital stock being substituted for the actual capital stock in calculating the long-run scale economies.[20]

3.2. Elasticities of Size and of Scale

As the previous discussion of a "polar" Ramsey world indicates, the ability of a railroad to earn a "fair" rate of return while charging a "fair" rate to its captive shippers primarily depends upon the nature of the size related economies facing the railroad. Table 2 presents estimates of the short-run and long-run returns to scale and their associated standard errors, for the following measures: Tons, which represents the usual measure of economies of density (eq (13a)); Proportional, which represents a proportional change in all of the components of output (eq (13c)); and Weighted, which incorporates the observed changes in all of the components of output (eq.(13d))[21] Although some standard errors are large relative to the parameter estimates, they indicate that the scale economies are estimated with an acceptable degree of precision. In general, there appears to be substantially more variation among different measures of returns to scale than between the short-run and long-run relationships for any given measure of returns to scale or between the railroads for any given measure of returns to scale.

TABLE 2

RETURNS TO SCALE, BY RAILROAD, SELECTED YEARS

	SHORT RUN					
	TONS		PROPORTIONAL		WEIGHTED	
	VALUE	STD ERR	VALUE	STD ERR	VALUE	STD ERR
bns						
mean	2.343	0.691	4.833	3.143	5.694	2.884
74	2.155	0.472	6.734	5.673	7.258	5.483
79	2.203	0.622	4.132	2.142	3.482	1.467
84	2.439	0.839	4.115	2.294	1.706	0.559
86	2.347	0.715	3.922	1.946	na	na
drg						
mean	2.433	0.642	3.170	0.911	na	na
74	2.415	0.454	4.132	1.130	3.069	0.585
79	2.421	0.561	3.419	1.008	na	na
84	2.410	0.940	2.110	0.638	na	na
crc						
mean	1.567	0.260	3.676	1.572	0.733	0.151
79	1.414	0.227	3.597	1.696	0.675	0.131
84	1.812	0.312	3.774	1.385	2.537	1.276
86	1.553	0.249	3.231	1.091	na	na
seabrd						
mean	3.125	1.375	na	na	1.127	0.554
74	3.236	1.406	na	na	1.127	0.554
79	3.049	0.386	na	na	na	na
chessie						
mean	1.715	0.358	5.917	4.856	na	na
74	1.783	0.386	5.764	4.251	na	na
79	1.637	0.337	5.405	4.111	na	na
csx						
mean	2.219	0.664	19.725	25.721	na	na
84	2.331	0.711	11.111	20.036	na	na
86	2.096	0.549	14.286	33.327	na	na
nw						
mean	1.447	0.276	3.344	1.350	na	na
74	1.462	0.339	3.521	1.659	na	na
79	1.403	0.282	3.185	1.306	na	na
southern						
mean	1.832	0.319	4.132	1.590	na	na
74	2.024	0.407	5.420	2.833	na	na
79	1.767	0.345	3.559	1.287	na	na
ns						
mean	1.802	0.314	6.472	5.832	na	na
84	1.733	0.343	5.208	3.565	na	na
86	2.137	0.493	16.129	39.839	na	na

	SHORT RUN					
	TONS		PROPORTIONAL		WEIGHTED	
	VALUE	STD ERR	VALUE	STD ERR	VALUE	STD ERR
mp						
mean	3.030	0.842	8.547	7.546	4.399	1.607
75	2.545	0.415	10.256	9.739	4.399	1.607
79	3.165	1.167	8.065	7.595	na	na
up						
mean	1.712	0.333	2.497	0.784	2.929	0.548
75	1.825	0.322	2.907	0.944	2.929	0.548
79	1.698	0.356	2.381	0.772	na	na
ups						
mean	2.222	0.548	4.988	3.135	2.775	3.196
84	2.203	0.554	5.025	3.266	2.775	3.196
86	2.381	0.617	4.938	2.905	na	na
atsf						
mean	1.866	0.388	2.845	0.957	na	na
79	1.838	0.375	2.786	0.970	na	na
84	1.905	0.421	2.793	0.946	1.172	0.118
86	1.835	0.422	2.706	0.890	na	na
gtw						
mean	1.681	0.427	3.788	1.402	na	na
75	1.502	0.420	3.846	1.747	8.912	9.687
79	1.715	0.489	3.247	1.148	2.709	1.110
84	1.866	0.406	3.503	0.953	1.529	0.770
86	1.972	0.522	5.025	2.554	na	na
icg						
mean	2.146	0.293	8.696	7.411	3.804	1.335
74	2.387	0.415	15.504	27.121	na	na
79	2.247	0.395	7.782	5.766	5.346	4.156
84	2.203	0.293	7.576	5.253	6.623	3.765
86	1.592	0.233	4.695	1.862	na	na
mkt						
mean	2.703	0.398	4.975	1.741	na	na
74	2.865	0.710	4.175	1.870	10.855	19.550
79	2.457	0.364	3.922	1.217	4.402	2.549
84	2.740	0.474	7.353	3.655	8.139	53.393
86	3.300	0.633	6.536	2.323	na	na
soo						
mean	4.274	1.800	4.762	2.737	2.970	2.465
74	3.831	1.598	4.831	2.780	20.233	78.953
79	3.731	1.497	4.274	2.496	1.845	0.429
84	3.610	1.467	4.292	6.286	3.413	3.725
86	7.519	6.913	na	na	na	na

TABLE 2, continued

RETURNS TO SCALE, BY RAILROAD, SELECTED YEARS

	LONG RUN					
	TONS		PROPORTIONAL		WEIGHTED	
	VALUE	STD ERR	VALUE	STD ERR	VALUE	STD ERR
bns						
mean	3.966	4.239	7.551	15.992	3.410	1.982
74	na	na	na	na	1.452	0.412
79	2.558	0.985	4.808	3.164	4.077	2.271
84	na	na	na	na	4.505	9.084
86	30.303	281.252	19.417	86.551	na	na
drg						
mean	2.237	0.510	3.236	0.812	na	na
74	2.247	0.415	3.906	0.967	4.634	1.391
79	2.105	0.451	3.252	0.761	na	na
84	2.304	0.691	2.448	0.653	na	na
crc						
mean	1.848	0.312	5.089	3.263	0.864	0.185
79	1.783	0.339	5.747	4.687	0.816	0.167
84	2.203	0.426	5.141	2.937	1.850	0.640
86	1.721	0.240	3.824	1.550	na	na
seabrd						
mean	3.968	2.520	na	na	0.816	0.320
74	6.757	8.413	na	na	0.816	0.320
79	3.597	2.149	na	na	na	na
chessie						
mean	1.658	0.332	5.348	3.798	na	na
74	1.795	0.395	5.865	4.591	na	na
79	1.553	0.303	4.706	2.997	na	na
csx						
mean	3.083	5.889	na	na	na	na
84	2.770	1.162	22.989	95.319	na	na
86	2.994	1.497	na	na	na	na
nw						
mean	1.969	0.681	5.208	2.847	0.605	0.413
74	6.452	13.182	na	na	0.605	0.413
79	1.832	0.617	4.598	3.325	na	na
southern						
mean	2.066	4.630	4.831	2.427	na	na
74	2.545	0.798	8.097	7.573	na	na
79	2.028	0.532	4.158	2.006	na	na
ns						
mean	3.968	2.993	na	na	4.059	12.208
84	5.376	6.802	na	na	4.059	12.208
86	2.278	0.599	23.810	91.756	na	na

	LONG RUN					
	TONS		PROPORTIONAL		WEIGHTED	
	VALUE	STD ERR	VALUE	STD ERR	VALUE	STD ERR
mp						
mean	5.747	4.614	7.752	14.252	1.553	0.526
75	na	na	na	na	1.553	0.526
79	na	na	na	na	na	na
up						
mean	3.984	3.322	3.906	4.472	2.024	0.524
75	5.917	7.498	5.277	8.136	2.024	0.524
79	3.333	2.356	3.623	2.436	na	na
ups						
mean	13.699	46.102	20.439	74.365	0.329	0.119
84	na	na	na	na	0.329	0.119
86	6.993	10.397	20.619	74.366	na	na
atsf						
mean	3.690	2.601	2.525	2.855	0.110	0.037
79	na	na	na	na	0.338	0.103
84	na	na	10.753	25.267	0.722	0.664
86	2.398	0.905	3.236	1.435	na	na
gtw						
mean	1.437	0.361	3.063	0.989	na	na
75	1.437	0.398	3.546	1.503	9.572	11.776
79	1.462	0.397	2.747	0.845	3.243	1.772
84	1.453	0.307	2.717	0.617	0.640	0.161
86	1.541	0.377	3.384	1.164	na	na
icg						
mean	3.096	0.804	58.824	51.922	8.854	9.326
74	3.484	1.206	na	na	na	na
79	3.077	8.530	19.802	45.262	na	na
84	2.882	0.607	17.094	30.391	10.720	11.125
86	2.732	0.863	31.250	108.933	na	na
mkt						
mean	3.390	0.695	6.192	3.144	0.722	0.201
74	10.989	12.820	8.929	11.849	0.807	0.197
79	2.433	0.358	3.891	1.191	4.384	2.498
84	3.876	1.488	13.605	17.040	na	na
86	2.681	0.414	5.222	1.552	na	na
soo						
mean	8.772	10.287	5.698	7.428	1.185	0.461
74	11.111	15.595	7.692	9.047	na	na
79	20.408	58.064	7.663	10.284	1.709	0.599
84	na	na	13.605	35.532	0.644	0.217
86	9.804	12.765	na	na	na	na

The short run returns to an increase in tons or ton-miles are generally quite large. In most cases they are greater than one at accepted level of statistical significance, and in many cases, they are substantially greater than one. Moreover, it is interesting to note that there appears to be little difference in the returns to scale between the coal and the non coal roads. Since the latter railroads have relatively fewer captive shippers than the coal roads, this suggests that they may have even greater difficulty in obtaining fair rates of return than the coal roads.

The long run returns to scale are generally somewhat larger than the short run returns to scale,[22] and in some cases are substantially greater, suggesting that the observed economies of scale may not be a transitional problem due to a disequilibrium in the capital stock, but may represent an innate technological characteristic of the railroad industry.[23]

The measures of proportional returns to scale are substantially larger than those for tonnage-related scale economies.[24] As discussed above, this is to be expected, since a proportional increase in tons and average length of haul increases ton-miles by a factor of two. For a given network, this increases the density of its usage concomitantly. As was true in the previous case, long-run returns to scale are typically greater than short-run returns, indicating that substantial returns to scale may be an inherent structural characteristic of the industry.

Clearly, however, the various components of output do not move proportionately, and the measure of weighted scale economies is more variable than the other measures of returns to scale. The short-run weighted returns to scale measure the returns to scale actually experienced by the railroads during the sample period.[25] These are generally qualitatively similar to the other

measures, although there are a few exceptions. For example, Conrail appears to have experienced periods of decreasing returns to scale, while the Seaboard System appears to have operated under conditions approximating constant returns before its merger with the Chessie system to form the CSX.

In spite of a few instances of decreasing or constant returns under the weighted scale economies, the evidence in Table 2 generally indicates that the railroads not only operate under substantial returns to scale under current capital structures, but that they will continue to do so if capital is adjusted in an optimal fashion. This, of course, may create a problem for policy if the markups required to ensure revenue adequacy or fair rates of return are greater than those deemed to be socially acceptable. This is the topic to which we now turn.

4. Policy Implications and Efficient Coal Rates

It is now useful to bring the threads of the previous two sections together and analyze their implications for the railroad rate structure. In Section 2 we developed a simple model relating the Ramsey rate structure to the markups over marginal cost that would be required to permit the railroads to break even. We showed that in the limiting case when captive traffic bore the entire revenue burden, the markup would be independent of the elasticity of demand in the captive sector, but would depend entirely on the returns to scale for a given railroad and the revenue share of the captive traffic under a competitive pricing regime. Section 3 then assessed the available evidence concerning economies of scale during the sample period.

In this Section we address the question of efficient coal rates. We first discuss the changes in coal rates relative to changes in other rates during the

sample period and then consider the relationship between prices and marginal costs that occurred during the sample period. We then turn to the rates that would be required in the captive sector if it were required to bear the entire revenue burden and assess whether "fair" rates are compatible with a "fair" rate of return.

4.1 The Behavior of Coal Rates

Table 3 presents the percentage change in revenues per ton (in current dollars) for the coal roads and the non-coal roads for five periods: the sample period 1974-86; the period prior to deregulation (1974-79); the period post deregulation (1979-86); and the subset of the period of deregulation from 1979-1984 and from 1984 to 1986.[26] This indicates that over the sample period, most railroads experienced substantially greater increases in coal rates than on other types of commodities. However, this differential rate increase was not uniform over the sample period among commodity types or among railroads. For example, during the period of major energy price increases, between 1974 and 1979, coal rates rose relatively more with respect to manufactured goods than they did with respect to agricultural goods. In contrast during the period of deregulation (1979-1986), the opposite happened with coal rates generally rising relatively more with respect to agricultural goods than manufactured goods. It is important to note, however, that the behavior of rates in the period of deregulation has not been uniform, with rates generally rising substantially more during the period 1979-84 than the period 1984-86. Moreover, during this latter period, coal rates have generally fallen relative to rates on manufactured and other goods.

It is interesting to note that there do not appear to be significant

TABLE 3

PERCENTAGE CHANGE IN RATES, BY RAILROAD,
SELECTED YEARS

COAL RAILROADS

	AGRIC	COAL	OTHER	TOTAL	REV/TONMI
bn					
1974-86	85.563	149.777	145.763	88.337	26.946
1974-79	76.752	74.107	56.331	44.342	17.365
1979-86	4.985	43.462	57.207	30.480	8.163
1979-84	21.92	65.51	41.20	35.04	16.33
1984-86	-13.89	-13.32	11.34	-3.38	-7.02
drg					
1974-84	174.24	282.64	191.81	163.88	72.56
1974-79	57.48	99.17	41.81	39.92	38.41
1979-84	74.14	92.12	105.78	88.59	24.67
conrail					
1979-86	174.24	282.64	191.81	163.88	72.56
1979-84	57.48	99.17	41.81	39.92	38.41
1984-86	74.14	92.12	105.78	88.59	24.67
sea/csx					
1974-86	130.23	185.21	166.73	145.86	24.00
1974-79	46.68	73.93	44.83	47.20	51.43
1979-86	56.96	63.98	84.17	67.02	-18.11
1979-84	49.83	84.79	75.49	61.70	31.70
1984-86	4.76	-11.26	4.95	3.29	-37.82
ches/csx					
1974-86	124.64	103.05	106.44	117.19	6.37
1974-79	37.12	56.23	64.68	56.72	58.82
1979-86	63.83	29.96	25.36	38.59	-33.02
1979-84	56.38	46.45	19.45	34.17	7.72
1984-86	4.76	-11.26	4.95	3.29	-37.82
nw/nss					
1974-86	56.47	108.84	103.94	101.17	100.00
1974-79	52.21	67.35	60.10	57.19	51.89
1979-86	2.80	0.77	3.12	0.00	-0.54
1979-84	17.82	23.85	23.52	27.98	32.38
1984-86	-12.75	0.77	3.12	0.00	-0.54
sou/nss					
1974-86	45.70	253.17	130.35	109.02	22.55
1974-79	60.64	72.32	56.37	55.11	-14.20
1979-86	-9.30	104.95	47.31	34.76	42.83
1979-84	3.95	103.39	42.85	34.76	43.61
1984-86	-12.75	0.77	3.12	0.00	-0.54

TABLE 3, CONT

PERCENTAGE CHANGE IN RATES, BY RAILROAD, SELECTED YEARS

NON COAL RAILROADS

	AGRIC	COAL	OTHER	TOTAL	REV/TONMI
mopac/ups					
1974-86	203.07	332.83	245.24	181.05	67.63
1974-79	80.58	96.97	60.32	56.09	39.88
1979-86	67.83	119.74	115.35	80.06	19.83
1979-84	52.96	99.49	69.80	55.59	25.62
1984-86	9.72	10.15	26.82	15.73	-4.61
up/ups					
1974-86	69.04	96.56	106.65	69.75	64.77
1974-79	52.08	76.83	46.32	42.78	28.41
1979-86	11.16	11.15	41.23	18.89	28.32
1979-84	1.31	0.91	11.36	2.74	34.51
1984-86	9.72	10.15	26.82	15.73	-4.61
atsf					
1979-86	26.41	12.25	90.28	43.09	22.35
1979-84	24.10	21.98	60.03	34.39	23.28
1984-86	1.87	-7.98	18.91	6.48	-0.75
gtw					
1974-86	38.72	189.80	123.51	81.34	66.46
1974-79	44.41	90.68	36.40	39.99	27.34
1979-86	-3.94	51.98	63.86	29.53	30.73
1979-84	4.10	119.45	56.11	41.25	21.43
1984-86	-7.73	-30.74	4.97	-8.29	7.65
icg					
1974-86	22.26	90.05	96.89	71.64	87.80
1974-79	57.71	64.82	47.42	53.92	33.04
1979-86	-14.33	15.31	33.55	11.52	41.15
1979-84	9.30	41.94	38.19	24.85	38.17
1984-86	-21.62	-18.77	-3.35	-10.68	2.16
mkt					
1974-86	87.97	665.64	54.47	59.31	79.21
1974-79	77.42	324.95	36.38	42.69	52.44
1979-86	5.95	80.17	13.26	11.65	17.56
1979-84	18.49	43.87	35.81	23.03	33.23
1984-86	-10.58	25.23	-16.60	-9.25	-11.76
soo					
1974-86	58.75	95.61	144.68	92.68	97.97
1974-79	57.12	57.93	45.60	49.66	48.30
1979-86	1.04	23.85	68.06	28.7	

differences with respect to the behavior of rates between the coal and non-coal roads or among the various coal and non-coal roads. In general the small roads experienced greater rate increases than the large roads, indicating that they may have been subject to somewhat less regulatory scrutiny than the larger roads. In all cases the rate differentials pre and post 1979 are striking, with rate increases being substantially less post 1979 than during the period of the 1970's. This is particularly true for agricultural products which exhibited very modest rate increases for all railroads post 1979. In contrast, rates on coal and manufactured and other goods rose substantially for most railroads during this same period, although rail rates increases in coal have slowed substantially post 1984 and in several cases have actually fallen.

While somewhat sketchy, this evidence suggests that energy price and other supply shocks rather than deregulation gave the railroads their greatest impetus to raise coal rates. Indeed, during the period 1974-1979, coal rates rose by over 75 percent for most railroads, while during the post-Staggers period their increases were substantially more modest, particularly after 1984. Given the large amount of economic rents on coal that had been generated by the rapid rise in oil rates during the 1970's it is not surprising that coal rates also rose dramatically. What is somewhat surprising, however, is the relatively modest rise in coal rates during the post-Staggers period for most railroads, particularly relative to rates on manufactured and other commodities. Here, several factors were doubtless at work. With respect to coal rates, the drop in energy prices reduced the potential coal rents and hence the railroads' ability to appropriate these rents. Thus the energy price drops mitigated the railroads' ability to exploit their market power with respect to coal.[27] Conversely, however, the pricing freedom given the railroads by the Staggers Act enabled them

to raise their rates on manufactured traffic, much of which had been transported at excessively low rates. Similarly, the rate competition engendered by the Staggers Act with respect to bulk agricultural commodities caused these rates to be relatively stable during the post-Staggers period. Thus the post-Staggers rate pattern involved comparable rate movements for coal and manufactured goods, both of which rose relative to agricultural commodities. Given these patterns of rate changes, it is difficult to argue that the Staggers Act unleashed the railroads to exploit their latent monopoly power with respect to coal shippers. Indeed, the evidences suggest that the economic rents associated with coal are a greater determinant of the railroads' ability to raise coal rates than deregulation.

This conclusion is strengthened by the evidence in Table 4, which provides information on the price increases in the general economy. In this connection it is interesting to note that rail rates on coal closely followed those of all energy prices throughout the sample period, but that they outstripped increases in the CPI, the finished goods index, and the farm products index. However, it should be noted that coal rates rose substantially more than energy prices in the post-Staggers period, indicating that deregulation did permit the railroads to exercise some latent market power. In contrast, agricultural rates tended to trail the non-energy price rises throughout the economy, particularly in the post-Staggers period. The behavior of manufactured rates was somewhat mixed, generally following the non-energy price increases in the economy throughout the 1970's, but generally exceeding them in the post-Staggers period.

Again, this implies that energy prices appear to be the principal determinant of coal rates while the regulatory and general economic environments were the principal determinants of other rates. In particular during the period of

regulation, rail rates on agriculture and manufactured goods appear to have followed those of other components in the economy. In the post-Staggers period, however, regulatory freedom and the resulting competition in agricultural commodities pushed agricultural rates down relative to general price increases. In contrast, the regulatory freedom accorded by the Staggers Act enabled the railroads to raise rates on coal and on manufactured goods, causing their rates to rise relative to energy prices and those in the non-energy sectors in the post-Staggers period. Nevertheless, on balance, deregulation seems to have had a smaller impact on coal rates than it has on agricultural or manufactured rates.

Table 4

Price Indices and Percentage
Change, by Index, 1974-86

	CPI (1967=100) total (a)	Producer Price Index (1967=100) Finished Goods:(b)	Energy: (c)	Farm Prod.(c)
1974	147.7	147.5	208.3	177.4
1979	217.4	217.7	408.1	229.8
1984	311.1	291.1	656.8	262.4
1986	328.4	289.7	483.5	251.9
Percent Change:				
74-86	122.3	96.4	132.1	42.0
74-79	47.2	52.8	95.9	29.5
79-86	51.0	33.1	18.5	9.6
79-84	43.1	33.7	60.9	14.2
84-86	5.6	-0.5	-33.2	-4.0

Source:
(a) Economic Report of the President, 1988, p. 313
(b) Economic Report of the President, 1988, p. 319
(c) Economic Report of the President, 1988, p. 322

4.2 Coal Rates and Efficient Prices

In terms of policy and considerations of economic efficiency, we are not so much interested in the behavior of rail rates relative to coal or other commodities as in the relationship of coal rates to marginal costs. In particular, it is now desirable to return to the initial question asked in this paper: namely is a polar Ramsey rate structure consistent with socially acceptable rates?

To answer this, it is useful to consider first the actual relationship between coal rates and marginal costs that existed over the sample period. We then turn an analysis of whether it is possible to achieve revenue adequacy while charging rates that are deemed to bear a politically or socially acceptable relationship to marginal costs.

4.2.1 Price-Marginal Cost Relationships

Table 5 presents the estimated short-run and long-run marginal costs for coal shipments, their associated standard errors, and the price/marginal cost markups for coal shipments for the railroads considered in this analysis.[28] Although the standard errors are large relative to the estimated marginal costs for a few railroads (e.g., Conrail, the CSX System), marginal costs are generally estimated with acceptable levels of precision. It is interesting to note that the long-run marginal costs are almost uniformly higher than the short-run marginal costs, indicating that marginal costs would rise substantially if capital were adjusted in an optimal fashion.[29] The marginal costs for the non coal roads are generally greater than those of the coal roads, with the long run marginal costs being relatively higher than the short-run marginal costs. Because these railroads ship relatively small amounts of coal, this is to be expected. They do not enjoy the economies of high volume and high density experienced by

TABLE 5

MARGINAL COSTS AND PRICE-MARGINAL COST RATIOS
FOR COAL, BY RAILROAD, SELECTED YEARS

COAL RAILROADS

	COAL MARGINAL COST ($/TON)				PRICE/MC RATIOS	
	SHORT	RUN	LONG	RUN	SHORT	LONG
Year	VALUE	STD ERR	VALUE	STD ERR	RUN	RUN
bns						
mean	6.36	1.53	8.87	2.18	1.026	0.736
74	2.75	1.62	9.85	2.34	1.629	0.455
79	6.91	1.54	7.80	1.65	1.129	1.000
84	7.53	1.96	10.85	3.91	1.714	1.190
86	6.40	1.65	9.35	3.02	1.748	1.197
drg						
mean	4.55	0.95	2.80	0.73	1.237	2.011
74	1.99	0.35	1.50	0.35	1.216	1.613
79	3.50	0.68	2.07	0.53	1.377	2.329
84	8.63	2.23	5.07	1.49	1.073	1.826
conrail						
mean	1.15	2.41	4.58	2.24	5.661	1.421
79	0.46	2.31	3.43	2.26	12.130	1.627
84	0.95	2.28	5.18	2.19	8.758	1.606
86	1.20	2.40	4.38	2.16	6.258	1.715
seabrd						
mean	2.29	1.25	2.77	1.33	1.594	1.318
74	1.64	0.91	2.53	1.05	1.567	1.016
79	2.74	1.57	3.17	1.64	1.631	1.410
chessie						
mean	0.83	1.08	0.67	1.05	5.855	7.254
74	0.35	0.71	0.37	0.71	10.314	9.757
79	1.00	1.38	0.75	1.13	5.640	7.520
csx						
mean	1.87	2.03	2.73	2.30	4.339	2.971
84	1.77	2.07	2.29	2.29	4.667	3.607
86	1.51	1.79	2.40	2.09	4.854	3.054
nw						
mean	1.76	1.09	2.35	1.27	3.943	2.953
74	0.70	0.74	1.77	1.32	6.300	2.492
79	2.04	1.30	2.71	1.54	3.618	2.723
southern						
mean	1.38	1.14	2.05	1.23	3.060	2.060
74	0.91	0.79	1.63	0.88	2.866	1.600
79	1.39	1.32	2.14	1.44	3.233	2.100
nss						
mean	2.96	2.05	4.85	2.63	3.159	1.928
84	1.74	2.03	4.23	3.04	5.253	2.161
86	3.95	2.01	4.24	2.05	2.332	2.172

TABLE 5, CONT

MARGINAL COSTS AND PRICE-MARGINAL COST RATIOS
FOR COAL, BY RAILROAD, SELECTED YEARS

NON COAL RAILROADS

	COAL MARGINAL COST ($/TON)				PRICE/MC RATIOS	
	SHORT	RUN	LONG	RUN	SHORT	LONG
Year	VALUE	STD ERR	VALUE	STD ERR	RUN	RUN
mopac						
mean	4.58	1.62	10.05	2.54	0.928	0.423
75	3.21	1.60	11.92	2.92	0.617	0.166
79	4.52	1.60	9.03	2.45	0.863	0.432
up						
mean	4.38	2.06	11.21	3.35	1.799	0.703
75	1.54	1.45	8.17	2.41	2.831	0.534
78	3.11	2.05	8.18	2.93	2.479	0.943
ups						
mean	5.95	2.38	13.96	4.61	1.311	0.559
84	6.04	2.67	19.00	6.66	1.288	0.409
86	4.70	2.17	8.86	3.13	1.823	0.967
atsf						
mean	6.96	2.91	23.30	5.88	0.973	0.210
79	1.33	2.88	32.92	9.02	4.283	0.173
84	7.46	3.13	20.69	6.03	0.931	0.336
86	9.54	2.93	13.70	3.23	0.670	0.467
gtw						
mean	1.74	2.20	na	na	2.222	na
75	na	na	na	na	na	na
79	na	na	na	na	na	na
84	2.21	1.86	na	na	2.929	na
86	3.47	1.53	na	na	1.292	na
icg						
mean	3.27	1.44	5.44	1.43	1.212	0.728
74	1.87	0.84	3.04	0.89	1.233	0.759
79	3.48	1.40	5.43	1.50	1.092	0.700
84	4.21	1.62	6.23	1.63	1.282	0.866
86	1.20	1.75	4.87	1.46	3.653	0.900
mkt						
mean	3.33	1.04	5.64	1.30	1.536	0.907
74	na	na	12.54	4.51	na	0.080
79	1.96	1.15	1.83	2.98	2.187	2.342
84	5.08	0.93	6.95	1.17	1.214	0.887
86	5.74	1.12	3.87	1.01	1.345	1.996
soo						
mean	29.87	17.98	63.45	21.25	0.186	0.092
74	5.11	4.99	19.44	6.48	0.595	0.156
79	14.66	10.71	49.03	14.84	0.328	0.098
84	9.20	16.67	84.77	26.87	0.799	0.087
86	9.09	1.92	9.73	2.02	0.655	0.611

the coal roads.

As we would expect, the short-run price/marginal cost relationships exceed unity for all of the coal roads throughout the sample. While these markups are relatively low for the Western coal roads, they are substantial for the Eastern coal roads, with the exception of the Seaboard System prior to merger. It is interesting to note, however, that there does not appear to be any pattern of increasing markups in the post-Staggers' period - if anything the markups over marginal cost are somewhat lower in 1986 than they were in 1974. This is consistent with the previous discussion which indicated that coal rates rose more in response to the energy shocks of the 1970's than in response to deregulation. Thus there does not seem to be any convincing evidence that the railroads are systematically exploiting their captive coal shippers. In addition, the long-run price/marginal cost markups are generally quite modest and substantially lower than the short-run markups. This is something of a statistical artifact, however, since it assumes that rates and output would remain constant if railroads adjusted their capital in an optimal fashion.

There is considerable variability among the price/marginal cost relationships on coal shipments within the non coal roads. Although coal rates exceeded short-run marginal costs for most railroads, the price/marginal cost markup was below unity in a few instances. In addition, the long-run price/marginal cost ratios are generally well below unity, reflecting the large differentials between the estimated short-run and long-run marginal costs. Since prices and outputs would adjust to long-run marginal costs, this indicates that coal rates would probably rise significantly on these railroads in long-run equilibrium.

4.2.2. Polar Ramsey Rates and Revenue Adequacy

We now turn to the basic question asked in this paper: Is there a rate structure that will permit the railroads to break even and earn a fair rate of return, while satisfying normally held views of equity about the burden and distribution of rates? To answer this question, we perform two counterfactual experiments: 1) determine the price/marginal cost markup that would accrue to the captive coal shippers if they had to bear the entire revenue burden; and 2) impose a socially acceptable predetermined markup on the captive coal sector and determine the average markup in the competitive sectors that would permit revenue adequacy.

Currently, there is no set view on what constitutes a socially acceptable markup over marginal cost. Historically, the ICC has tended to view rates in excess of 150 percent of variable costs with suspicion.[30] Although the Staggers Act stated that rates in excess of 180 percent of variable cost constituted *prima facie* evidence of "market dominance" and thus provided shippers with cause to challenge rates, in recent years the ICC has used a standard of stand-alone cost in determining rate cases. Since stand-alone costs reflect the costs that would occur if the railroad dedicated its facilities to the shipments in question and did not spread its overhead over other shipments, stand-alone costs are typically quite high. Nevertheless, in view of the statutory language of the Staggers Act and the political pressures that have been raised by the captive rail shippers, it is unlikely that public opinion would support rates that are substantially in excess of three hundred percent of marginal costs. Moreover, in view of the existing price/marginal cost relationships, a markup of three would signify a substanial rate increase on coal traffic on average. Thus, while admittedly arbitrary, we take a price/marginal cost markup of three to signify the limit of

social acceptablity. However, the qualitative findings of this paper would not be changed if the limiting socially acceptable markup were set somewhat higher or lower.

Table 6 presents the polar Ramsey markups for the railroads used in this analysis based on the tons-related measure of returns to scale, which the previous analysis indicated provides the most reliable measure of returns to scale.[31] With only a few exceptions they are above three, and in most cases they are substantially higher, in both the short run and the long run. This indicates that if captive coal traffic had to bear the entire burden of revenue adequacy, it is unlikely that this could be achieved at a level of coal rates that would be considered socially acceptable. This raises the more general question of whether the railroads can be financially viable given the constraints on rates that are placed by truck competition on the one hand and by social attitudes toward "excessive" rates on the other.

To examine this question, we perform the counterfactual experiment of imposing a rate ceiling on coal traffic of three hundred percent of marginal costs and determine the average markup that would be required on the remaining traffic to ensure revenue adequacy. This "required" competitive markup is also given in Table 6 for the ton-related measure of economies of scale. Based on short-run marginal costs for the coal railroads in the post-Staggers period, this figure ranges between 1.2 and 2.0. The short-run required competitive markups for the non coal railroads are somewhat higher, generally ranging between 1.5 and 3.0. This indicates that most railroads could achieve revenue adequacy with a rate structure that should not be viewed as excessively discriminatory. The long run competitive markups are not only more variable but are also generally higher than the short-run competitive markups for both the coal and the non coal roads,

TABLE 6

POLAR RAMSEY MARKUPS, REQUIRED COMPETIVE MARKUPS,
MANUFACTURED PRICE-MARGINAL COST MARKUPS
BY RAILROAD, SELECTED YEARS

COAL ROADS

Year	Polar Markup Short Run	Polar Markup Long Run	Compet Markup Short Run	Compet Markup Long Run	Manufac p/mc ratio Short Run	Manufac p/mc ratio Long Run
bns						
mean	4.339	4.078	1.901	29.365	1.437	1.474
74	10.650	na	2.040	na	1.933	2.508
79	3.872	3.820	1.628	2.012	1.717	1.695
84	3.740	na	1.818	na	2.177	2.525
86	3.959	na	1.802	na	2.718	2.931
drg						
mean	3.636	4.685	1.758	1.852	2.051	2.744
74	5.202	6.174	2.119	2.008	2.697	2.988
79	3.779	4.816	1.816	1.740	2.448	3.181
84	3.089	4.094	1.184	1.797	1.825	2.643
conrail						
mean	20.196	6.602	1.524	1.643	2.802	2.918
79	35.555	7.556	1.395	1.618	3.212	3.807
84	33.914	7.413	1.782	2.019	3.207	3.326
86	20.321	6.762	1.510	1.538	2.986	2.958
seabrd						
mean	8.636	7.902	3.173	4.699	na	na
74	9.291	7.500	3.324	35.849	na	na
79	8.532	7.982	3.067	3.951	na	na
chessie						
mean	9.679	11.189	1.600	1.566	na	na
74	15.952	15.270	1.715	1.724	na	na
79	9.356	11.135	1.524	1.469	na	na
csx						
mean	10.481	8.758	2.104	3.113	na	na
84	11.312	9.858	2.232	2.713	na	na
86	21.495	17.045	2.045	2.993	na	na
nw						
mean	4.452	5.038	1.216	1.643	3.017	3.395
74	1.600	na	nb	na	4.210	8.659
79	4.018	4.537	1.157	1.472	3.005	3.408
southern						
mean	12.675	9.870	1.742	1.939	3.766	4.033
74	14.727	10.102	1.946	2.451	6.247	7.413
79	12.606	9.768	1.680	1.899	3.663	3.922
nss						
mean	6.692	6.540	1.605	5.086	3.708	5.887
84	9.798	7.446	1.618	10.402	4.512	10.764
86	6.092	5.996	1.889	2.030	4.305	4.466

na: not available
nb: not binding

TABLE 6, CONTINUED

POLAR RAMSEY MARKUPS, REQUIRED COMPETIVE MARKUPS,
MANUFACTURED PRICE-MARGINAL COST MARKUPS
BY RAILROAD, SELECTED YEARS

NON-COAL ROADS

Year	Polar Markup Short Run	Polar Markup Long Run	Compet Markup Short Run	Compet Markup Long Run	Manufac p/mc ratio Short Run	Manufac p/mc ratio Long Run
mopac						
mean	9.924	na	3.039	na	2.985	3.821
75	14.101	na	2.484	na	2.930	6.248
79	8.943	na	3.226	na	3.215	4.081
up						
mean	8.410	5.918	1.575	5.503	1.343	1.475
75	25.170	8.871	1.783	10.773	1.513	1.660
78	10.058	6.677	1.589	3.566	1.594	1.700
ups						
mean	6.902	na	2.019	na	2.602	3.953
84	7.477	na	2.021	na	2.208	5.373
86	8.420	na	2.239	na	4.117	4.869
atsf						
mean	11.738	5.615	1.766	4.654	1.474	1.795
79	42.544	na	1.814	na	1.510	2.934
84	8.210	na	1.748	na	1.442	1.681
86	5.652	5.070	1.580	2.083	1.601	1.571
gtw						
mean	26.541	na	1.645	na	2.730	2.707
75	na	na	na	na	2.871	2.850
79	na	na	na	na	3.493	3.268
84	22.348	na	1.818	na	2.809	2.767
86	8.817	na	1.826	na	4.570	4.822
icg						
mean	8.644	6.630	1.995	3.153	2.327	2.513
74	8.746	6.676	2.253	3.861	3.383	3.632
79	8.719	6.905	2.102	3.119	2.154	2.240
84	8.130	6.641	2.041	2.823	2.205	2.289
86	16.696	6.989	1.537	2.623	2.305	2.883
mkt						
mean	14.761	10.028	2.661	3.530	1.486	1.522
74	na	14.111	2.871	na	1.618	1.700
79	29.758	31.593	2.428	2.405	1.362	1.364
84	8.619	7.448	2.663	4.581	1.579	1.611
86	9.207	11.814	3.417	2.622	1.405	1.459
soo						
mean	20.283	na	4.534	na	1.941	1.998
74	35.125	na	3.907	na	2.508	2.508
79	25.552	na	3.823	na	1.988	2.116
84	61.291	na	3.638	na	1.682	1.851
86	na	na	na	na	2.771	2.780

na: not available
nb: not binding

in many cases being well in excess of 3.0. This is consistent with our estimates of large long-run economies of scale and suggests that the current difficulties facing the railroads concerning revenue adequacy may not be a transitional problem, but a manifestation of an inherent technological characteristic of rail technology.

In addition to being socially acceptable, the rate structure must also be feasible in the presence of strong truck competition. Table 6 also presents the estimated price/marginal cost markups for manufactured and other commodities, which are generally greater than the competitive markups that would be required for revenue adequacy if coal rates were held to a ceiling of three hundred percent of marginal costs. This suggests that most railroads could achieve revenue adequacy while sustaining a rate structure that does not place an undue burden on any class of shippers. It is important to note, however, that this is not true for all railroads, with the non coal railroads appearing to be more vunerable than the coal railroads.

5. Summary and Conclusion

The implications of the findings of this paper for the ability of the railroads to achieve revenue adequacy and to earn a "fair" rate of return while charging "fair" rates are somewhat mixed. On the negative side are two principal results: 1) railroads appear to operate under substantial returns to scale in both the short-run and under long-run equilibrium adjustments to their capital stock; and 2) if captive shippers are forced to bear the entire burden of revenue adequacy, it is likely that coal rates would have to rise to socially unacceptable levels relative to marginal costs. This suggests that there may be

considerable justification in the recurring concerns of utilities and other "captive" coal shippers over the level of coal rates.

In spite of these negative findings, the situation is probably not this bleak, since most railroads typically appear to receive a greater contribution to overhead from manufactured and other commodities than from coal. Not only are the estimated price/marginal cost markups for manufactured commodities typically greater than those on coal, but they are often substantially higher in both the short-run and the long-run. This indicates that despite the rhetoric of the captive shippers, the actual revenue burden place upon them probably lies within politically and socially aceptable levels.

More generally, a comparison of the actual price/marginal cost ratios with those required to sustain profitability indicates that a significant increase in rates may not be required. In particular, if we impose a rate ceiling of three times marginal cost on the captive coal traffic, the markups on the remaining traffic that are required to sustain a normal rate of return are generally within the bounds of the actual price/marginal cost markups on manuafactured and other traffic. Thus although particular railroads may have problems achieving revenue adequacy and there may be continued pressures to raise rates on captive coal shippers, on balance it appears that no one type of shipper should be subject to monopoly "exploitation" to permit the railroads to achieve revenue adequacy. Nevertheless, it is important to stress that this conclusion is heavily dependent on the finding that the railroads currently enjoy substantial markups on their truck competitive traffic and do not have to impose the entire burden of revenue adequacy upon their captive coal shippers.[32] If trucking costs were to fall substantially through the introduction of double bottoms, the revenue burden on captive shippers would increase concomitantly and pressures for reregulation

could well return.

In conclusion then, the findings of this paper cautiously support the argument for workable competition in the rail industry under existing cost structures in the rail and trucking industry In spite of the evidence of substantial scale economies in both the short-run and in long-run equilibrium, the existing rate structure and traffic distribution appear to permit consistency between "fair" rates and "fair" rates of return for most of the railroads considered in this analysis. Nevertheless, this conclusion is somewhat fragile, since it depends heavily on the ability of the railroads to continue to earn a significant contribution to overhead on their truck competitive traffic. Were this ability to diminish -- either through technical change such as the introduction of double bottoms or increased competitive pressure from trucks -- the ability of the railroads to achieve revenue adequacy and an equitable rate structure could well erode.

NOTES

1. The question of the maximum permissible rates on captive traffic has a somewhat complicated history. Although the Staggers Act indicated that rates in excess of 180 percent of variable cost constituted prima facie evidence of market dominance and should therefore be subject to review by the Interstate Commerce Commission (ICC), the ICC has currently adopted guidelines based on "constrained market power" which are broadly based on Ramsey pricing principles. In brief, the ICC permits railroads to charge captive shippers a higher "share of unattributable costs than shippers in competitive markets," (812 Federal Reporter, 2nd Series, p.1454) subject to the following four constraints: (1) The railroads earn no more than a normal profit and achieve no more than revenue adequacy; (2) The railroads must operate efficiently so that shippers cannot be charged for managerial or operating inefficiencies; (3) The shipper cannot pay more than stand alone costs; (4) The rate cannot be imposed immediately if it would disrupt the shipper unduly, but instead must be phased in over time." (812 Federal Reporter, 2nd Series, p.1450). In addition, see Consolidated Rail Corporation vs. United States, 812 F 2nd 1444 (3rd Cir, 1987).

2. Because of the large element of fixed costs and the economies of scope associated with rail service, it is likely that stand alone costs will be quite high. See Willig and Baumol (1987) for a defense of the use of stand-alone costs as a rate ceiling in multi-product markets.

3. Consumers United for Rail Equity (CURE) has emerged as a potent force lobbying Congress for tighter regulation on coal rates. In 1989 legislation was narrowly defeated in committee that would have reduced the ability of railroads to raise rates on all shippers, set an effective ceiling on rates for captive shippers, and force railroads to give trackage and yard rights to their competitors. Since then the pressures for reregulation have abated somewhat

4. It should be noted that we are not so much interested in the question of whether the railroads are natural monopolies as the question of whether there is a feasible rate structure that would ensure revenue adequacy while fulfilling generally held views of equity. To determine if railroads were natural monopolists, we would have to determine if their rate structure was subadditive (i.e., whether a single railroad could perform the service it produces more cheaply than a number of separate railroads, each specialized in carrying a single commodity type). Because we utilize ton-miles as the relevant output measure and because data on ton-miles are not available by commodity type, it is not possible to perform this analysis. However, since track and structures represent a high proportion of total rail costs and are common to all commodities carried by a given railroad, it is likely that rail technology is subadditive.

5. See Meyer and Tye (1988) for a good discussion of this market equilibrium.

6. See Baumol and Bradford (1970) for a discussion of Ramsey pricing in the case of a public utility operating under a break-even constraint. Recent arguments in favor of the adoption of Ramsey pricing for the railroads are contained in Baumol (1983), Baumol and Willig (1983), Goldfeld (1983), and Willig (1983). Nevertheless, it is important to note that the case for Ramsey pricing depends on a number of assumptions that are unlikely to be realized. For instance, in the presence of interdependent demands, intermodal competition, downstream users (i.e., coal-burning utilities and manufacturing firms), a non-optimal distribution of income, and price distortions elsewhere in the economy, the case for Ramsey pricing becomes considerably weaker. For a discussion of these and related points see Damus (1979), Braeutigam (1979), and Diamond (1975).

7. This is the usual definition of ray economies of scale. See Bailey and Friedlaender (1982) for a discussion of this and other measures of scale economies in a multiproduct setting.

8. Equation (6) follows from the familiar Ramsey pricing formula of $(p_i - mc_i)/p_i = \theta/\epsilon_i$. To solve for the Ramsey markups where a degree of monopoly power exists in each sector, we would substitute the Ramsey markups given in eq (6) into eq(4) and solve for θ. This yields a quadratic equation in θ, which is not amenable to a closed form solution.

9. See Meyer and Tye (1985, 1988) for a good discussion of these points.

10. See Caves, Christensen, and Swanson (1981), Brown, Caves and Christensen (1979), Harmatuck (1979), Friedlaender and Spady (1981) and Caves et al. (1985) for related work on rail costs.

11. It should be stressed, however, that this is a partial equilibrium analysis that assumes output levels are fixed at their current levels. To determine a full equilibrium would require estimates of the demand side of the market, which is beyond the scope of this paper.

12. See Vellturo (1989) and Berndt et al. (1990) for analysis of rail mergers.

13. The other railroads included in the sample that were not affected by merger were: the Chicago Northwest Transit; the Kansas City Southern; the Missouri Kansas Texas; and the Southern Pacific. The results for these railroads were not reported because they failed to satisfy a sufficient number of regularity conditions to give an adequate picture of their behavior over the sample period.

14. Costs and related variables were all measured in 1974 dollars to abstract from the effects of inflation

15. See Mundlak (1978), Vellturo (1989) and Berndt et al. (1990) for a full discussion of this point. Most analyses of fixed effects assume that they affect total costs alone (e.g., Mundlak (1978) and Caves et al. (1985). Because we assume that these effects may be related to factor utilization and that firms are able to minimize costs with respect to variable factors, we

introduce them into the linear terms of the factor price expressions within the cost function. We do not, however, introduce them into the capital stock terms because we assume that firms are not able to minimize costs with respect to ws capital.

16. The instruments used were related to firm-specific demand variables and included mine-mouth coal prices, coal production, oil prices, farm income, and the value of manufacturing shipments. To test the hypothesis of endogeneity, whe system of equations was estimated in two ways: first by a 3SLS procedure that assumed that output and its related variables were endogenous; and second, by a maximum liklihood (ML) procedure that assumed that all of the regressors were uncorrelated with the error terms. Under the null hypothesis of exogeneity ML estimation is effifient, while 3SLS is consistent. If the alternative hypothesis of endogeneity is true, only 3SLS is consistent. The χ^2 statistic corresponding to the null hypothesis that $B_{3SLS} = B_{ML}$ was 1252.99, which is much larger than the critical value with 38 degrees of freedom at any reasonable level of significance. This indicates that output and its related variables should be treated as endogenous. Hence the cost function and its associated input share equations were estimated by 3SLS, with demand-related instruments used for output and its related variables.

17. Since $y = H \bullet T$, $dy/y = dH/H + dT/T$. Consequently, if $dH/H = dT/T = dQ/Q$, then $dy/y = 2dQ/Q$.

18. See Keeler (1985) and Caves et.al (1985) for a related discussion of measures of returns to scale.

19. The opportunity cost of capital for each firm i at time t is defined by $P_{it} = (r_{it} + \delta)$, where P_{it} represents the price index of railroad structures and capital at time t; r_{it} represents the bond rate for railroad i at time t; and δ represents the rate of depreciation. See Vellturo (1989 for a full definition of this and related variables.

20. This notion of the long run imputes all of the adjustment to the fixed factor x_F and keeps output as given. An alternative approach, not considered here, holds x_F fixed and requires output to change. Since this latter experiment would require some notion of the demand side of the market, it was beyond the scope of this analysis.

21. We do not present estimates of the returns to scale with respect to average length of haul. In a preponderance of cases, the absolute value of the partial elasticity of costs with respect to average length of haul (e_{CH}) was larger than the partial elasticity of cost with respect to ton-miles, causing the measured elasticity of cost with respect to average length of haul to be negative (i.e., $E_{CH} = e_{CY} + e_{CH} < 0$). Thus the resulting measures of these returns to scale were meaningless.

22. In some cases the size of the optimal capital stock was sufficiently low to cause the long-run returns to scale to be negative. In that case, we utilized the symbol "na" in Table 2.

23. See Friedlaender et al. (1990) for a discussion of optimal capital adjustment of the railroads in the sample.

24. If the scale economies with respect to average length of haul are sufficiently negative, this measure of returns to scale can be negative. When this occurs, we have written "na" in Table 2.

25. Because some of the relative output changes are quite large and because some of the partial output elasticities are negative (e.g., average length of haul, percentage of coal), the weighted cost eleaticity can be negative. When this occurs, we have written "na" in Table 2. The weights used to calculate the weighted returns to scale for each year are given as follows: mean (1986-1974)/1974; 1974 (1979-1974)/1974; 1979 (1984-1979)/1979; 1984 (1986-1984)/1984. Thus there is no measure of weighted returns to scale for 1986.

26. Technically deregulation formally began with the passage of the Staggers Act in 1980. Because administrative deregulation began in 1978 with the appointment of Darius Gaskins as Chair of the ICC and because of the timing of the energy shocks, we use 1979 as the base year of deregulation instead of 1980.

27. For analysis of the relationship of coal rates and the economic rents associated with coal, see Zimmerman (1979) and Atkinson and Kerkvliet (1986).

28. Because data on specific traffic types and rates are given in terms of tons, it is necessary to estimate marginal costs in terms of tons instead of ton-miles. Since, however, aggregate ton-miles is simply the product of tons and average length of haul, the two are obvioulsy related, and it is possible to estimate the marginal costs per ton for the broad commodity types used in this analysis. Long run marginal costs can be estimated by substituting measures of the optimal capital stock in the estimated cost function. It should be noted that since this formulation assumes that all commodities have the same average length of haul, marginal costs are doubtless estimated with some error.

29. Friedlaender et al. (1990) have found that during the period of deregulation, capital has been relatively slow to adjust. Thus the transition to long-run marginal costs may take some time to occur.

30. See Friedlaender (1969) for a discussion of the ICC's historical attitudes toward the equitable relationship between rates and variable costs.

31. Marginal cost revenues were obtained from the relationship $rR = C$, where r = returns to scale, R = marginal cost revenues, and C = total costs. Thus for tons-related measure of returns to scale, r, we otain a comparable measure of marginal cost revenues. The marginal-cost revenue share of the captive traffic (coal) was thus obtained by taking the ratio of actual marginal-cost coal revenue to the calculated marginal cost revenues. Using these data, it was straightforward to calculate the polar Ramsey markup given in eq (5) for the relevant measure of returns to scale. It should be noted that these estimates of the polar Ramsey markups are based on a partial equilibrium analysis that assumes that output is fixed. Of course, if the polar

Ramsey markups acutually obtained, output and the resulting measures of scale economies would doubtless change.

32. Unpublished studies by the ICC and the American Association of Railroads provide qualitatively similar findings concerning the relationship between rates and variable costs for manufactured and other commodities.

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